derms the series divaricates into the double-fluid series and single-fluid series, the former coinciding with the radiate and articulate class, and joining the Vertebrata through the Crustacea; the latter running parallel with the Molluscan order, and connecting itself to the Vertebrata through the Cephalopods.

The fluids of the zoophytic series are invariably corpusculated, but the corpuscles cannot yet be reduced to any definite type of conformation. In the Medusan series these bodies become more definitively organized. The author then demonstrates, that throughout the whole radiate and articulate classes, wherever it is found, the *chylo-aqueous* fluid is richly corpusculated, or in other words, charged with floating morphotic elements, which, from the constancy of their characters in different species, become grounds for specific distinctions. It is stated, that, throughout the Echinoderms, Entozoa and Annelida, in which, even in the adult animal, the blood-proper and the chylo-aqueous fluid, though separate, coexist, the latter fluid only is corpusculated, the true blood being invariably limpid and perfectly fluid (incorpusculated), and almost always the seat of the colour; the latter existing as a substance dissolved in the fluid, while in no instance does colour develope itself in the chylo-aqueous fluid.

The paper then shows, that at the point where the chylo-aqueous system disappears, namely at the Myriapods, the true blood becomes the vehicle of the corpuscles.

And lastly, the author adduces a great variety of observations in confirmation of the statement, that throughout the whole Molluscan series without exception, coinciding with his "*single-fluid series*," the fluids are richly charged with corpuscles.

The paper is accompanied by numerous illustrations, displaying the characters of the morphotic elements of the circulating fluids of the Invertebrata.

March 25, 1852.

SIR J. HERSCHEL, Bart., V.P., in the Chair.

A paper was in part read, entitled, "Experimental Researches in Electricity: Twenty-ninth Series." By Michael Faraday, Esq., D.C.L., F.R.S. &c. Received Dec. 31, 1851.

April 1, 1852.

COLONEL SABINE, R.A., V.P. and Treas., in the Chair.

The reading of Dr. Faraday's paper, "Experimental Researches in Electricity: Twenty-ninth Series," was resumed and concluded.

In the present series of researches the author endeavours in the first place to establish the principles he announced in the last, with regard to the definite character of the lines of magnetic force, by

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results obtained experimentally with the magnetic force of the earth. For this purpose he reverts to the thick wire galvanometer before described, and points out the precautions respecting the cleanliness of the coils, the thickness and shortness of the conductors, the perfect contacts, effected either by soldering or cups of mercury; and marks the value of double observations, i. e. observations afforded on both sides of zero. The nature of the impulse on the needles is pointed out; being not that of a constant current for a limited or unlimited time, but of a given amount of electricity exerted, either regularly or irregularly, within a short period; and it is shown experimentally that such impulses produce equal results of deflection, and also that when two or more such impulses are given within a limited time, the whole arc of swing is nearly proportional to their number; so that the amount of deflection, *within certain limits*, indicates directly, nearly the proportion of electricity which has passed as a current through the instrument.

If a wire be formed into a square of 12 inches in the side, and then fixed on an axis passing across the middle parallel to two of its sides, and if, when that axis is perpendicular to the line of dip, the whole is rotated, then two of the sides of the rectangle will, in one revolution, twice intersect the lines of force of the earth passing across or through one square foot of area. The currents then tending to move in the upper and lower parts of the rectangle, will conjoin to urge one current through the wire; and if this wire be cut at one place close to the axis, and be there connected with a commutator of simple construction, which is described in the paper, the currents round the rectangle may be conveyed away to the galvanometer, and there measured. Such a rectangle, constructed of copper wire one-twentieth of an inch in thickness, gave a certain arc of swing for one revolution. If five or ten revolutions were made, within the time of vibrating of the needle, nearly five or ten times this amount of deflection was produced: the mean result, in the present case, was 2°·624 per revolution. When the same length of the same wire was arranged in oblong or oblate rectangles, so as to diminish the inclosed area in different directions as regarded the axis of revolution, still the deflection was in every case proportional to the areas included; showing that the effect produced was proportional to the number of lines of force intersected by the moving wire. The same result was obtained when two squares having areas in the proportion of 1 to 9, were employed.

When squares of the same area were formed of copper wire of different thicknesses, then the effects of obstruction in the conducting part of the system were brought out and measured. Thus, with wires which were 0·05, 0·1 and 0·2 of an inch in diameter, and therefore in mass as 1, 4, and 16, the deflections were 1, 2·78, and 3·45; a result almost identical with that obtained for the same wires by the use of loops and a local magnet in the former researches. When two equal rectangles were compared, one containing a single circuit of 4 feet of wire 0·1 in thickness, and the other four circuits of 16 feet of wire 0·05 in thickness, then the first was found to evolve the largest quantity of electricity; but the second, electricity of the highest tension, by the same amount of motion: the accordance of these results with the principles advanced is pointed out. The author then refers to the use of wire rings of one or many convolutions, and indicates cases in which they may supply valuable means of experimental inquiry.

The relative amount and disposition of the forces of a magnet when it is alone, or associated with other magnets, forms the next point in the present paper; and a distinction is first taken between ordinary magnets, which are influenced much by other magnets, so that the amount of their external force varies greatly, and those which are very hard, where this influence is reduced to little or nothing. The power of a given magnet was measured according to the method described in the last series, by a loop once passed over its pole. A given hard magnet placed in an invariable position, being thus estimated, was found to have a force equivalent to 16°·3 of deflection. Another magnet, having a power of 25°·74, was then placed close to the first in different positions, with like or unlike poles near together, so as to tend sometimes to exalt its power and at other times to depress it; and the results observed. In the extremest favourable case, namely, when the two were conjoined as a horseshoe magnet, the force of the first magnet was only raised 2°·45, which fell directly the dominant magnet was removed; in the corresponding adverse case the depression was only 1°. A very hard magnet, made by Dr. Scoresby, of 6°·88 power, when under the influence of another of double its power, was not sensibly affected either way. When under the influence of one of six times its force, it could be affected to the extent of nearly 1°. Ordinary magnets can be affected to the extent of one half of their power or more; and indeed in extreme cases can be altogether overruled and inverted.

From these results the author concludes, that, with perfect unchangeable magnets, the lines of force (as before defined) of different magnets in favourable positions, coalesce: that there is no increase of the total force by this coalescence; the sections between the associated poles giving the same sum of power as the sections of the lines of either magnet alone: that as the external amount of force of the magnet is not varied, neither is the internal amount at all changed: that the increase of power upon a magnetic needle, or a piece of soft iron, placed between two opposite favourable poles, is caused by concentration of the lines which before were diffused, and not by the addition of the power represented by the lines of force of one pole to that of the lines of force of the other. There is no more power represented by *all* the lines of force than before, and a line of force is not in itself more powerful because it coalesces with a line of force of another magnet. In this and in other respects, the analogy of the magnet with the voltaic pile is perfect.

The paper concludes with some practical remarks upon the delineation of the forms of the lines of force by iron filings, and by a description of the inflection of the lines by hemispheres of hot and cold nickel; which the author considers as the corresponding case to the action of warm and cold oxygen in the atmosphere, as applied by him in the explication of some of the phenomena of atmospheric magnetism, and especially of the annual and daily variation.

A paper was also read, entitled, "On the Electro-chemical Polarity of Gases." By W. R. Grove, Esq., M.A., F.R.S., &c. Received January 7, 1852.

The author refers to the experiments of Faraday on dielectric induction, to those of Gassiot on the increase of electrical effects of tension, according as the chemical intensities of a voltaic battery are increased, and to other results, which, though supporting the view of a physico-polar state of gaseous substances intervening between oppositely electrified surfaces, have not hitherto shown any change in the arrangement of the gaseous particles dependent upon their chemical characteristics.

The electric or voltaic disruptive discharge has hitherto presented only one phenomenon which offers any analogy to electrolysis, viz. that observed by Mr. Gassiot and others, of the positive terminal being more intensely heated than the negative, when the voltaic discharge passes between metals. With the voltaic arc the effects of heat and the destruction of the terminals so interfere with any effects properly due to the transmission of the electric current, that it is next to impossible to eliminate the latter; on the other hand, with the electric spark from an ordinary machine, the quantity of matter acted on is too minute to give satisfactory evidence of the changes taking place. Mr. Grove sought an intermediate degree of electrical action, and by the aid of an apparatus of Ruhmkorf for producing a powerful secondary current, the results detailed in this paper were mainly obtained.

A polished silver plate is laid on the pump plate of a good air-pump, and a metallic point is attached to the rod passing through a collar of leathers at the top of the receiver, the point being adjusted at from one-eighth to one-fourth of an inch distance from the plate. Caustic potash is kept suspended in the receiver, and a mixture of oxygen and hydrogen, or atmospheric air and hydrogen, allowed to enter it, and then attenuated until the barometer stands at half an inch; the discharges from the secondary coil are now made to pass between the point and the plate, when if the latter be positive it is oxidated, if negative the spot of oxide is reduced.

If there be excess of oxygen and little or no hydrogen, oxidation takes place, whether the plate be positive or negative, though in different degrees; and if the gas be wholly or mainly hydrogen, reduction takes place whether the plate be positive or negative.

At certain intermediate states of mixture rings or zones of alternate oxidation and reduction are shown, quite distinguishable from the ordinary succession of colours of thin plates, and showing alternations or periods of interference of electrical action.

The author then gives the results of experiments with several other metals, of which bismuth was the only one he found to produce effects anything like equal to the silver, though other metals showed them in some degree.

He also varied the gas or gases employed, and details the results